Resource Adequacy and Managing Unilateral Market Power in Wholesale Electricity Markets

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Outline of Presentation

- Installed capacity equal to 115 % to 117% of peak load along will not prevent a future California electricity crisis
  - For the same amount of installed capacity, the incentives of suppliers to exercise unilateral market power are the same with or without a capacity market
- Sufficient fixed-price forward contracts between suppliers and California load-serving entities (LSEs) provides a contractual guarantee against a future California electricity crisis
  - Buying a large fraction of demand in advance severely limits the ability of suppliers to exercise market power in the spot market
- A capacity market paradigm does not address the problem of guaranteeing the financial viability of LSEs
  - Without adequate forward purchases of energy, LSEs face a significant risk of high spot prices for a sufficiently long period of time to bankrupt them
- Impossible to guarantee physical resource adequacy in wholesale market regime
  - Even with a must-offer requirement, suppliers must be willing to provide enough energy from their generation units to meet demand
- Resource adequacy in a wholesale market regime is an economic construct
  - Suppliers must have a financial incentive to produce enough energy at reasonable prices to meet demand
  - The costs of failing to meet demand must be sufficiently high for suppliers to find it unilateral profit-maximizing to fulfill their contractual obligations

Major Cause and Cure for "Crisis"

- Inadequate fixed-price forward contracting by California LSEs
  - Suppliers earned spot market price on virtually all MWh sold
  - Reduction in import availability during early summer of 2000 increased incentives of suppliers to withhold capacity from California market by
    - Bidding substantially higher prices to supply energy
    - Withholding generation capacity from market—Sick day problem
- No evidence that inadequate generation capacity was a factor in crisis
  - No rolling blackouts during entire Summer 2000 or Summer 2001
    - Peak period of annual demand cycle
- Forward contracts signed by state during Winter and Spring of 2001 committed suppliers to California market beginning in June of 2001
  - Significantly reduced incentives for suppliers to withhold capacity
  - Very small fraction of energy produced and consumed in California paid spot-market price
  - Significant amount of new generation capacity built as a physical hedge for these forward contract commitments sold by suppliers

Installed Capacity and Market Power

- Installed capacity suppliers must offer generation capacity to spot market if it is available
  - Bid price must be less than price cap on spot market
  - Suppliers can still declare a sick day
    - Impossible to verify if unit is truly unable to operate
      - Experience of CPUC during June 2000 to June 2001
    - Penalty of reduced installed capacity to sell in future period is insufficient to prevent "sick days" when they are profitable
- Apparent success of must-offer requirement under current market design is largely due to current level of fixed-price forward contracting for energy
- Adequate installed capacity to meet demand peaks cannot prevent energy shortfalls
  - Energy shortfalls more of a concern in hydro-based and import-dependent system such as California
  - No surprise that all market meltdowns around the world have occurred in hydro-based systems with inadequate fixed-price forward contracting for energy
    - New Zealand, Brazil, Chile

Forward Contracts for Energy

- What does an LSE get from fixed price forward contract
  - Supplier will bid to reduce spot energy price until it covers its forward contract position
    - Suppliers are net demanders of energy until they cover their forward market positions
  - Forward contract commitment limits incentive of supplier to exercise unilateral market power in spot market
    - See "An Empirical Analysis of the Impact of Hedge Contracts on Optimal Bidding Behavior in a Wholesale Electricity Market," available from web-site.
- Fixed-price forward contract holdings by LSEs at current levels would have largely prevented California electricity crisis
- If California LSEs have fixed-price forward contract commitments for 100% of expected load obligations in advance of real-time
  - Consumers have a contractual guarantee against a future California electricity crisis
    - Persistently high spot prices or energy shortfalls
  - Even with reduced import availability, sellers of forward contracts would still have strong financial incentive to supply energy to California at lowest possible price

Capacity Markets and LSEs

- What does an LSE get from buying installed capacity (ICAP)?
  - Commitment that ICAP supplier bids into spot market at or below bid cap if it is available to supply electricity
  - ICAP suppliers will exercise all available unilateral market power though bids into energy market
  - ICAP payment does not prevent ICAP suppliers from withholding capacity from market for energy
    - May reduce amount of ICAP supplier can sell in future periods, but this may not constrain behavior if ICAP supplier can raise energy prices substantially
- An installed capacity market that has purchased adequate generation capacity to meet the demand peaks still exposes LSEs to a significant risk of a sustained period of very high spot prices if they are not adequately hedged
  - Significant probability of bankruptcy of LSEs

Impossibility of Physical Resource Adequacy

- Tying provision of forward contracts to specific generation facilities artificially and unnecessarily increases costs of supplying energy to LSEs
  - Seller of contract may claim higher cost unit will produce energy, but the seller always has the option to substitute cheaper energy for output of this unit
  - Recall that it is physically impossible to deliver electrons to a specific location in the network
  - Seller will always choose least-cost source of supply in real-time, so why pay for anything else in forward market
- Under contract adequacy approach, suppliers jointly have very strong incentive to obtain cost-least dispatch of generation facilities in real-time
  - Suppliers jointly have strong incentive to undertake transmission upgrades that reduce spot prices
- Clear separation between forward market hedging activities and units dispatched in real-time gives suppliers maximum flexibility to meet these future energy obligations and strongest possible incentive to reduce spot prices
  - LSEs signing purely financial forward contracts provides maximum flexibility
  - With significant forward contracting, supplier share desire of LSEs to set lowest possible spot prices for energy

Contract Adequacy

- By focusing on contract adequacy—sufficient financial contracts to hedge future spot price risk--allows market to find least-cost future generation mix
  - If retailers are prudently hedging future energy obligations with fixed-price swap contracts, cap-contracts or other financial instruments that best suit their hedging needs
  - Suppliers will respond with least-cost physical generation portfolio to hedge these financial obligations that they have sold
  - No need for intervention to determine future generation technology investments
- CPUC must ensure that LSEs hedge spot price risk at locations in network that LSE withdraws energy in advance of delivery to give market best opportunity to suppliers to provide least-cost physical hedge for this future spot price risk
  - Because of incentive to test integrity of bid cap at $250/MWh (or even at $1000/MWh), CPUC must set minimum levels of forward contract coverage for energy in all hours of the years at various delivery horizons
    - Recall that rolling blackouts occurred during months of January to March

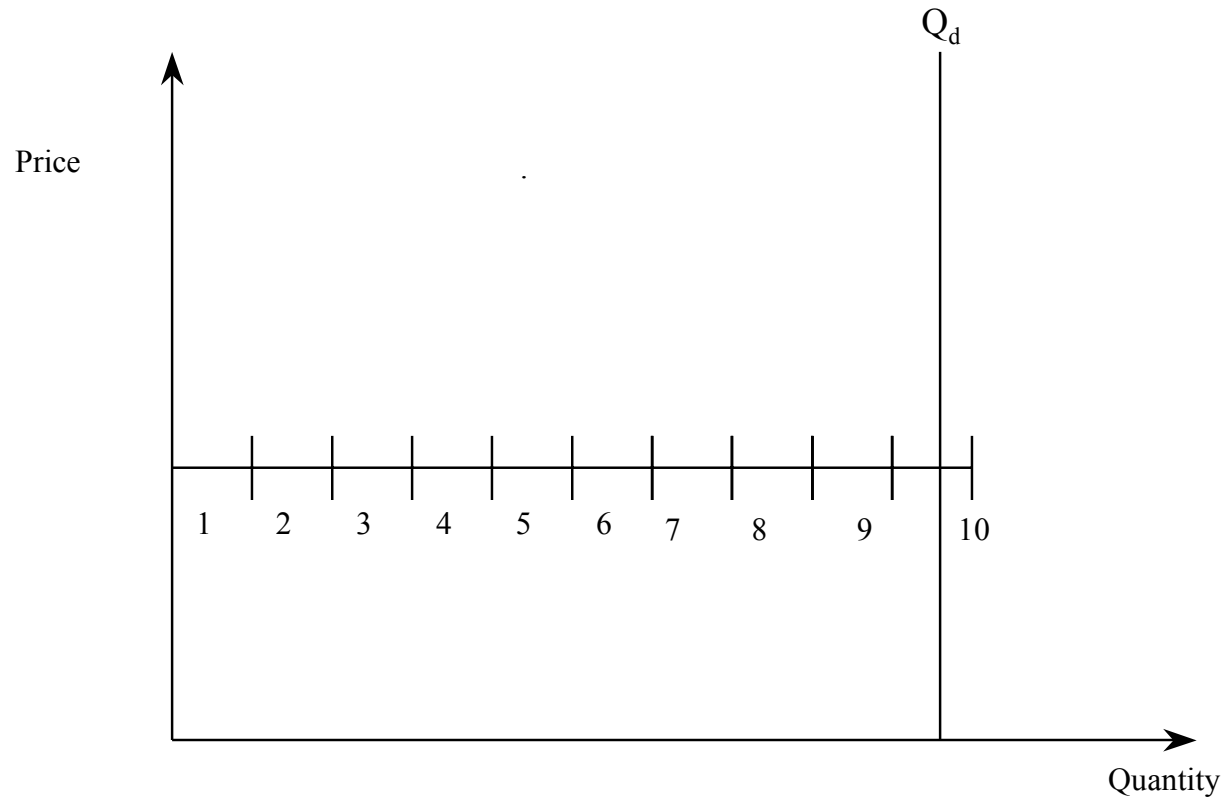
Financial Incentives

- Supplier sells 500 MW forward contract to LSE that clears against location A at price of $25/MWh
  - Typically both buyer and seller pay spot price for all energy they inject and withdraw from network in real-time
- Supplier has a strong incentive to keep spot price as low as possible, unless it sell more than 500 MWh of energy
  - LSE is owed $100,000 = [(225-25) $/MWh]*500 MW by supplier
  - If supplier is unable to pay, LSE may institute bankruptcy proceedings against supplier
- If CPUC has ensured minimal contracting levels and supplier sell more than 500 MW of energy, then it is unlikely to be able raise spot price through it bidding behavior

Benefits versus Costs of Capacity Payments

- Consumers are likely to pay less for capacity in the short-term because of current supply and demand balance in Colombia
  - Total capacity payments will be more volatile in short and long term
- Over long term it is very likely that consumers will pay more in capacity payments and there will less new capacity built
  - Consumers are likely to pay more because capacity markets, such as proposed peak power capacity auction, are extremely susceptible to the exercise of unilateral market power
  - Inelastic demand for capacity and inelastic supply of capacity
    - Recall that firm power market buys existing generation capacity
  - When no supplier is pivotal
    - Price = marginal cost of supplying existing capacity = 0
  - When one supplier is pivotal
    - Price = min(infinity, price cap

Firm Power Auction--Pivotal Supplier



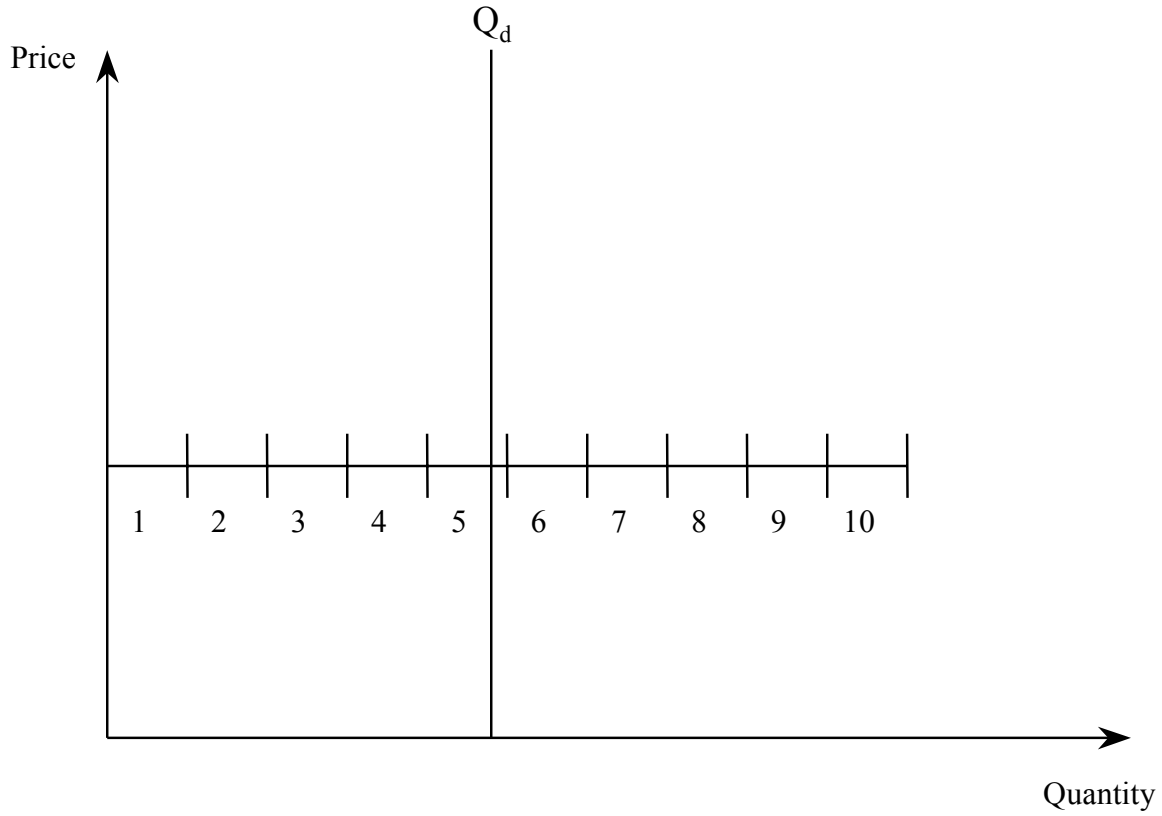
10 Firms--Each has 1 MW to sell, Market Demand is 9.5 MW

Marginal Cost = $0/MW, Price Cap of $10,000/MW

Firm Power Auction Equilibrium

- 9 firms all bid $0/MW for one 1 MW
- 1 firm bids $10,000/MW for 1 MW
- Equilibrium price is $10,000/MW
- Each of 9 firms bidding $0/MW has no incentive to unilaterally change its bid
  - Earns highest possible profit given capacity
- 1 firm bidding $10,000/MW has no incentive to unilaterally change its bid
  - Cannot increase price
  - Decreasing price only reduces profit
  - Reductions in quantity can only reduce profit

Firm Power Auction—No Pivotal Supplier



A Nash equilibrium to this auction is that all firms bid zero and each sell $Q_d/10$.

Suggested Modification of ECxC

- Continue with current prospective dispatch to process to determine value of CRT for each generation unit in system
  - For each supplier compute PCRT = Portfolio CRT = Total MWs of CRT allocated to that supplier
  - Supplier continues to receive CRT times administrative capacity payment (currently $US 5.25/kW-month) for each generation unit owned
  - In exchange supplier must provide PCRT of availability to system 24 hours per day, 7 days per week, and 365 days per year
  - Availability is the total amount of generation capacity supplied to market at a bid price less than or equal to bid cap on spot market
    - Value of supply curve level at the bid cap on the spot market

Suggested Modification of ECxC

- Supplier with given value of PCRT must ensure that this amount of MWs of generation capacity is bid into the market either from units its owns or from other capacity in the system that is not satisfying this PCRT requirement during all hours of month
- Suppliers to that fail to provide this amount availability will be charged the cost of shortage per MW (roughly $US 1/kWh) that they fail to provide
- Example—Supplier with 500 MW PCRT and 800 MW of capacity
  - Every hour of month supplier must bid into spot market at least 500 MW from these generation units or other generation capacity that is not being used to satisfy the PCRT requirements of other suppliers
    - For units it does not own suppliers much notify CND what capacity is meeting this requirement each hour or be subject cost of shortage penalty
  - Suppose that only 400 MW of this supplier's unit have bid into the market (because remaining capacity is forced out) supplier must find 100 MW of other capacity in system that does not satisfy PCRT requirement to bid in
    - May need to compensate the supplier doing this on their behalf
    - Failure to do implies a $1000/MW*100 MW penalty

Suggested Modification of ECxC

- Scheme guarantees that system operator will have generation capacity available to sell energy at or below the bid cap on the spot market that is at least equal to the sum of the values of CRT across all generation units every hour of the month
  - Satisfactions of this scheme implies that if the demand in the month never exceeds total of CRT across all generation units in the system the market will always have sufficient generation capacity available to meet energy demand
- It implies a different perspective on capacity payment
  - Payment for guaranteeing a given MWs of availability, not paying for MWs of installed capacity

Suggested Modification of ECxC

- Suppliers in the aggregate receive the same amount of capacity payments as they currently do
  - Costs of any purchases of availability in bilateral market by suppliers must be paid by them, because capacity payment is for providing PCRT value in MWs of availability all hours of the month
  - Market power by one supplier exercised in this bilateral market must be borne by suppliers purchasing availability, not final consumers
    - Should not to be a serious problem, because one supplier is unlikely to be consistently on buying or selling side
  - Different from CCxC scheme where higher price in firm power capacity market due to market power of supplier is passed on to final consumers in their total capacity payments

Transition to Forward Contracts for Energy

- Convert existing capacity payment mechanism into fixed price "cap" contract of following form
  - Run prospective dispatch process to determine value of firm energy, FE, for each generation unit and the value of CRT for that generation unit
  - In exchange for receiving fixed payment each month for each generation unit equal to the value of CRT times the capacity charge, the supplier must make payment for month equal to
    - Max(0,P(avg)-P(hist_avg))*FE*(number of hours on the month)
    - P(avg) = average Bolsa price of during that month
    - P(avg_hist) = average Bolsa price in that month over past 5 years
- This payment scheme implies that if the average Bolsa price for that month is less than the historical average Bolsa price over the past five years
  - The supplier receive the full capacity payment for this month
  - This provides strong incentives for all suppliers to bid and operate their generation units to keep the average Bolsa price for the month below this historical level despite the fact that the supplier would like to sell its energy in the highest priced hours of the month

Transition to Forward Contracts for Energy

- To transition from the administrative capacity charge to a forward contracts for energy market, each year the values of CRT and FE would be multiplied by a factor, f, ($0 < f < 1$), that becomes smaller each year and eventually equals zero
- The supplier would receive f*CRT times the capacity charge each month in exchange for the payment obligation
  - Max(0,P(avg)-P(hist_avg))*FE*f*(number of hours on the month)
    - P(avg) = average Bolsa price of during that month
    - P(avg_hist) = average Bolsa price in that month over past 5 years
    - FE = firm energy for that generation unit
- As this payment scheme phases out suppliers are free to sell their energy in the spot market or through bilateral contracts for energy

Transition to Forward Contracts for Energy

- CREG must set would set portfolio standards and contracting levels for various delivery horizons for LSEs
  - LSEs would be required to meet these standards or face financial penalties
- A sample portfolio standard and delivery horizon
  - 1 year from delivery 100% of forecast demand in forward contracts
  - Portfolio must be composed of at least 85% swaps, with the remainder in caps at average strike price less than 3 times average spot price from previous year

Frequency of Prices in Victoria, Australia

	Year 2001	Year 2002
p > $4000/MWh	0.00017	0.00011
$4000 > p > $2000	0.0012	0.00091
$2000 > p > $1000	0.0010	0.00057
$1000 > p > $500	0.0014	0.00086
$500 > p > $100	0.0070	0.0072
$100 > p > $50	0.0426	0.0431
$50 > p	0.9466	0.9472
Annual Mean	$36.01	$33.15
Current bid cap = $10,000/MWh		